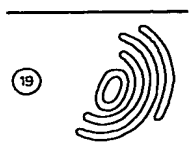


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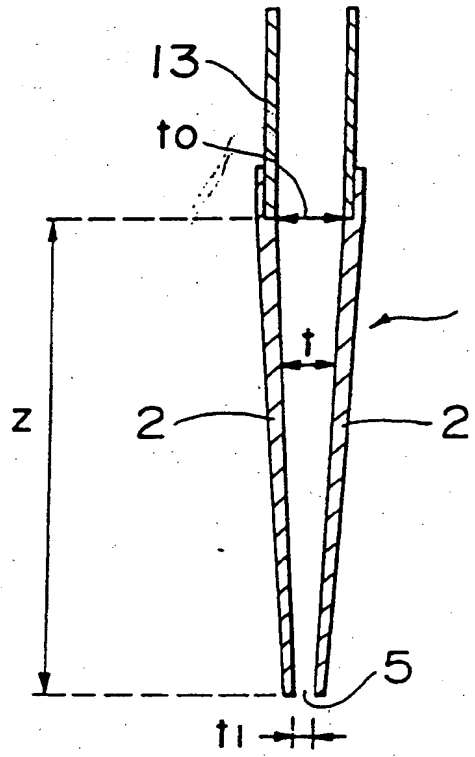
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⑤4 **FILAMENT DISPERSING DEVICE.**

⑤7 A filament dispersing device capable of dispersing a group of filaments evenly and widely on the moving collecting surface by reducing disturbance of grouped filaments while controlling the air flow as a conveying medium for the grouped filaments. The device (1) consists of a dispersing pipe composed of a pair of upright dispersing plates (2) opposite to each other and a pair of side plates (3) to connect said dispersing plates to each other, and provided with an inlet for grouped filaments at the upper part and a slender outlet (5) at the lower part encircled by said dispersing plates and side plates for jetting filaments, in which, when assuming that the distance between said inlet and outlet (5) is  $z$ , the longer the distance  $z$ , the shorter the gap  $t$  between the dispersing plates and the wider the gap  $W$  between the side plates. This dispersing device can reduce disturbance of the conveying air flow and disperse grouped filaments evenly and widely on the collecting surface (14), thereby providing webs rarely having irregularities and filament bundles, and being good in appearance.

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【 1 】



## Technical Field

The present invention relates to a filaments dispersing device for the production of a nonwoven fabric, for flatly dispersing filaments carried by an air flow.

## Background Art

In a known producing method for a nonwoven fabric, numerous filaments ejected from a spinning nozzle are drawn by an air gun and are stretched. Then, the filaments are carried by an air flow into a guide tube, and are dispersed in a dispersing device (usually formed as a dispersing nozzle or a dispersing pipe). Then, the filaments are collected on a moving collector surface to thereby form a web.

In Japanese Patent Publication No. 47-24991, there is described a device for dispersing and depositing filaments to produce a fleece (a kind of web). As a dispersing portion of this device, there are shown in the above reference an example wherein a space  $w$  between opposed side plates (corresponding to side walls) of a dispersing pipe and a space  $t$  between opposed dispersing plates (facing parts of the dispersing pipe other than the opposed side plates) are linearly changed (Fig. 1 in the above reference); an example wherein the space  $w$  between the opposed side plates is increased toward an outlet (filaments outlet) of the dispersing pipe in such a manner that a radius of curvature of the opposed side plates is gradually decreased toward the outlet (Fig. 2(a) in the above reference); and an example wherein the space  $w$  between the opposed side plates is linearly increased along tangential lines of arcs and the arcs are connected with expanded ends of the tangential lines (Fig. 2(b) in the above reference).

However, in the dispersing device formed as the dispersing pipe as described in Japanese Patent Publication No. 47-24991, a change in sectional area of the device is large, or the space  $w$  between the opposed side plates is rapidly increased toward the filaments outlet. Accordingly, the air flow in the device separates from the opposed side plates and the opposed dispersing plates, causing remarkable turbulence of the air flow. As a result, the filaments carried by the air flow are largely disturbed to cause the generation of yarn bundles damaging the appearance of the web.

## Disclosure of Invention

The present invention has been realized in view of the above circumstances, and it is an object of the present invention to provide a dispersing device which can disperse filaments uniformly and widely on a moving collector surface by suppressing the turbulence of an air flow as a carrier medium for the filaments to thereby reduce the disturbance of the filaments.

According to the present invention achieving the above object, there is provided a filaments dispersing device for the production of a nonwoven fabric, for dispersing filaments carried by an air flow and ejecting said filaments onto a moving collector surface, said filaments dispersing device being formed as a dispersing pipe comprising a pair of dispersing plates vertically extending so as to be opposed to each other and a pair of side plates connecting said dispersing plates, said dispersing pipe having an upper end formed with a filaments inlet and a lower end formed with an oblong filaments outlet surrounded by said dispersing plates and said side plates, said dispersing pipe having a shape such that a space  $t$  between said dispersing plates is decreased with an increase in distance  $z$  from said filaments inlet toward said filaments outlet, and that a space  $w$  between said side plates is increased with the increase in said distance  $z$ .

In the dispersing device of the present invention, it is preferable that a sectional area  $S$  of the dispersing pipe at an arbitrary portion thereof in a plane perpendicular to a line along the distance  $z$  (which sectional area will be hereinafter referred to simply as a sectional area  $S$  of the dispersing pipe) is represented by an expression approximated to Expression 1 to be given below, and that  $dw/dz \geq 0$  and, preferably  $d^2w/dz^2 \leq 0.3$ , more preferably  $d^2w/dz^2 \leq 0.006$  are satisfied for all values of the distance  $z$ .

Expression 1:  $S = a \times z + b$

where  $a$  is a constant satisfying  $-1.00 \leq a \leq 1.00$ , preferably  $a = 0$ ; and  $b$  is a sectional area of the filaments inlet.

It is preferable that the space  $t$  between the dispersing plates is a monotone decreasing function of the distance  $z$ .

It is preferable that the space between the dispersing plates at the filaments outlet is 1 mm or more in consideration of operability.

It is preferable that a condition for carrying the filaments in the dispersing device having the above shape is such that an air velocity  $V_a$  at the filaments outlet is represented by a ratio of  $Q/S_{end}$  where  $Q$  represents a flow rate of the air flow and  $S_{end}$  represents a sectional area of the filaments outlet, and that the air velocity  $V_a$  is related with a filaments velocity  $V_f$  so as to satisfy  $2V_f < V_a < 4V_f$ .

There will now be described a preferred embodiment of the present invention with reference to the drawings.

Referring to Fig. 5, there is shown a nonwoven fabric producing apparatus to which the present invention is applied. The nonwoven fabric producing apparatus includes a spinneret 11 as a spinning nozzle for filamentously extruding a molten resin, an air gun 12 provided below the spinneret 11 for receiving filaments A extruded from the spinneret 11, stretching the filaments A, and ejecting the same with a high-speed air flow, a guide tube 13 connected at an upper end thereof to the air gun 12 for carrying the filaments A with the air flow, and a moving collector surface 14 as an air permeable screen belt provided below the guide tube 13. Furthermore, a dispersing device 1 according to the present invention is provided at the level of about 100 to 600 mm above the moving collector surface 14 so that an upper end of the dispersing device 1 is directly connected to the guide tube 13.

The dispersing device 1 is constituted of a pair of flat dispersing plates 2 vertically straight extending so as to be opposed to each other as shown in Fig. 1 and a pair of side plates 3 connecting the dispersing plates 2 so as to be curved away from each other as shown in Fig. 2.

A distance  $z$  from a filaments inlet of the dispersing device 1 to a filaments outlet 5 thereof is set to about 20 to 400 mm. An outlet of the guide tube 13 is connected to the filaments inlet of the dispersing device 1 so that there is no step between an inner surface of the guide tube 13 and an inner surface of the dispersing device 1.

The guide tube 13 has an inner diameter of 6 to 20 mm, for example. About 200 filaments each having a size of 0.3 to 15 D (denier) are ejected with an air flow of 20 to 60  $Nm^3/hr$  from the guide tube 13.

In correspondence with that the inner diameter of the guide tube 13 is set to 6 to 20 mm, an inner diameter  $t_0$  of the filaments inlet of the dispersing device 1 connected to the guide tube 13 is also set to 6 to 20 mm.

A space  $t$  between the opposed dispersing plates 2 is gradually decreased with an increase in value of the distance  $z$  from the filaments inlet, and a space  $t_1$  at the filaments outlet 5 is set to 0.7 to 3 mm, for example. On the other hand, a space  $w$  between the opposed side plates 3 is gradually increased with an increase in value of the distance  $z$  from the filaments inlet.

As shown in Fig. 3, a horizontal cross section of the dispersing device 1 consisting of the dispersing plates 2 and the side plates 3 in combination (i.e., a cross section perpendicular to a line along the distance  $z$ , and having a sectional area  $S$ ) is shaped so that it is substantially square at an upper end portion 4a of the dispersing device 1 where the value of the distance  $z$  is short; it is substantially rectangular at an intermediate portion 4b of the dispersing device 1 where the value of the distance  $z$  is medium; and it is flatly rectangular at a lower end portion 4c as the filaments outlet 5 of the dispersing device 1 in such a manner that each short side corresponding to the space  $t$  is set to 0.7 to 3 mm, for example, and each long side corresponding to the space  $w$  is set to 20 to 100 mm, for example.

In the dispersing device 1 shown in Figs. 1 and 2, there is the following relation between the distance  $z$  and the space  $w$ . That is, an inclination of the dispersing plates 2,  $dw/dz$  is set to zero or positive, and a rate of increase thereof,  $d^2w/dz^2$  is set to 0.6 or less, preferably 0.3 or less. In particular, there is no step between the upper end of the device and the outlet 14 of the guide tube 13, so that the inclination,  $dw/dz$  at a connecting portion ( $z = 0$ ) is zero.

There is shown a relation among  $w$ ,  $t$ , and  $S$  in Fig. 6. The relation is expressed as follows:

$$t = -0.076 \times z + 9.000$$

$$S = -0.11 \times z + 81.00$$

$$S = w \times t$$

The above expression of  $S$  and  $z$  is approximated to Expression 1 mentioned above.

The dispersing plates 2 and the side plates 3 are not limited to the flat plates as mentioned above, but they may be curved as viewed in horizontal cross section. For example, as shown in Fig. 4, the horizontal cross section of the dispersing device 1 consisting of the dispersing plates 2 and the side plates 3 in combination may be shaped so that it is substantially circular at an upper end portion 6a of the dispersing device 1; it is elliptical at an intermediate portion 6b of the dispersing device 1; and it is flatly elliptical at a lower end portion 6c as the filaments outlet 5 of the dispersing device 1 in such a manner that a major axis is much longer than a minor axis.

As a modification, the horizontal cross section may be so shaped as to combine the elliptical shape and the rectangular shape.

The filaments outlet 5 of the dispersing device 1 is located at the level of 100 to 600 mm from the screen belt 14. The filaments A carried through the guide tube 13 at high speeds are gathered in more convergent manner in opposed directions of the dispersing plates 2 and are spread in opposed directions of the side plates 3 along the curves of the side plates 3. Thus, the filaments A are uniformly dispersed in the dispersing device 1 and are then ejected from the filaments outlet 5.

In the nonwoven fabric producing apparatus as shown in Fig. 5 employing the filaments dispersing device as shown in Figs. 1 and 2, the filaments A can be dispersed in the range of 600 mm or more by varying the height from the screen belt 14 or the velocity of the air flow, for example.

#### Brief Description of the Drawings

Fig. 1 is a vertical sectional side view of a preferred embodiment of the dispersing device according to the present invention;

Fig. 2 is a vertical sectional elevational view of the dispersing device shown in Fig. 1;

Fig. 3 is a horizontal sectional view of the dispersing device shown in Fig. 2;

Fig. 4 is a horizontal sectional view of a modification of the dispersing device shown in Fig. 2;

Fig. 5 is a schematic view of a nonwoven fabric producing apparatus employing the dispersing device of the present invention;

Fig. 6 is a graph showing a relation among a distance  $z$  from a filaments inlet to a filament outlet of a dispersing device used in Example 1, a space  $w$  between side plates of the dispersing device, a space  $t$  between dispersing plates of the dispersing device, and a sectional area  $S$  of the dispersing device;

Fig. 7 is an illustration of air velocity distribution in the dispersing device used in Example 1;

Fig. 8 is a graph showing a relation among a distance  $z$  from a filaments inlet to a filament outlet of a dispersing device used in Comparison 1, a space  $w$  between side plates of the dispersing device, a space  $t$  between dispersing plates of the dispersing device, and a sectional area  $S$  of the dispersing device;

Fig. 9 is a vertical sectional view of the dispersing device used in Comparison 1;

Fig. 10 is an illustration of air velocity distribution in the dispersing device used in Comparison 1;

Fig. 11 is a graph showing a relation among a distance  $z$  from a filaments inlet to a filament outlet of a dispersing device used in Comparison 2, a space  $w$  between side plates of the dispersing device, a space  $t$  between dispersing plates of the dispersing device, and a sectional area  $S$  of the dispersing device;

Fig. 12 is a graph showing a relation among a distance  $z$  from a filaments inlet to a filament outlet of a dispersing device used in Comparison 3, a space  $w$  between side plates of the dispersing device, a space  $t$  between dispersing plates of the dispersing device, and a sectional area  $S$  of the dispersing device;

Fig. 13 is a graph showing a relation among a distance  $z$  from a filaments inlet to a filament outlet of a dispersing device used in Comparison 4, a space  $w$  between side plates of the dispersing device, a space  $t$  between dispersing plates of the dispersing device, and a sectional area  $S$  of the dispersing device; and

Fig. 14 is an illustration of air velocity distribution in the dispersing device used in Comparison 4.

#### Best Mode for Carrying Out the Invention

An example of the present invention will now be described.

As shown in Fig. 5, the dispersing device (dispersing pipe) 1 of various shapes was connected to the guide tube 13 having an inner diameter of 10 mm. With an air flow of 42 Nm<sup>3</sup>/hr, 100 polypropylene filaments A each having a size of 2 denier was carried at a velocity of  $V_f = 3000$  m/min. The screen belt 14 as the moving collector surface having a suction device was located below the filaments outlet of the dispersing device 1 by 150 mm. The filaments A ejected from the dispersing device 1 were collected on the screen belt 14 to obtain a web. The dispersing device 1 was disposed so that the dispersing plates were perpendicular to a moving direction of the moving collector surface 14. A dispersion width of the filaments A, an air velocity distribution from the filaments outlet, and an appearance of the web were evaluated.

## (Example 1)

A dispersing device having such a shape as to be represented by the space  $w$  between the side plates, the space  $t$  between the dispersing plates, and the sectional area  $S$  of the dispersing pipe as shown in Fig. 6 (i.e., the dispersing device as shown in Figs. 1 and 2) was mounted in the nonwoven fabric producing apparatus as shown in Fig. 5. Then, the evaluation was carried out. The air velocity distribution is shown in Fig. 7, and the results of the evaluation are shown in Table 1.

## (Comparison 1)

A dispersing device having such a shape as to be represented by the space  $w$  between the side plates, the space  $t$  between the dispersing plates, and the sectional area  $S$  of the dispersing pipe as shown in Fig. 8 (i.e., the dispersing device as shown in Figs. 9 and 2) was mounted in the nonwoven fabric producing apparatus as shown in Fig. 5. Then, the evaluation was carried out. The air velocity distribution is shown in Fig. 10, and the results of the evaluation are shown in Table 1.

## (Comparison 2)

A dispersing device having such a shape as to be represented by the space  $w$  between the side plates, the space  $t$  between the dispersing plates, and the sectional area  $S$  of the dispersing pipe as shown in Fig. 11 was mounted in the nonwoven fabric producing apparatus as shown in Fig. 5. The results of the evaluation are shown in Table 1.

In Comparison 2, turbulence of the air flow at the filaments outlet was remarkable, so that the air velocity distribution could not be measured.

## (Comparison 3)

A dispersing device having such a shape as to be represented by the space  $w$  between the side plates, the space  $t$  between the dispersing plates, and the sectional area  $S$  of the dispersing pipe as shown in Fig. 12 was mounted in the nonwoven fabric producing apparatus as shown in Fig. 5. The results of the evaluation are shown in Table 1.

In Comparison 3, the ejected air velocity was beyond a measurable range, so that the air velocity distribution could not be measured. However, it was confirmed that the air velocity along the side plates was remarkably high.

## (Comparison 4)

A dispersing device having such a shape as to be represented by the space  $w$  between the side plates, the space  $t$  between the dispersing plates, and the sectional area  $S$  of the dispersing pipe as shown in Fig. 13 was mounted in the nonwoven fabric producing apparatus as shown in Fig. 5. The air velocity distribution is shown in Fig. 14, and the results of the evaluation are shown in Table 1.

Table 1

	$S$ (Send) (mm <sup>2</sup> )	$V_a$ (m/min)	$d^2w/dz^2$ (max)	Dispersion Width (mm)	Web Appearance
Example 1	$S = -0.11z + 81.0$ (70)	10000	0.29	240	⊙
Comparison 1	$S = (0.32z + 7.50) \times (-0.03z + 7.50)$ (120)	5800	-	90	x
Comparison 2	$S = (-0.08z + 9.00) \times (0.43z + 9.00)$ (72)	9700	-	75	x
Comparison 3	$S = -0.82z + 81.0$ (40)	17500	0.57	220	x
Comparison 4	$S = 0.64z + 56.25$ (183)	3800	0.04	100	○

The criterion of the evaluation of the web appearance in Table 1 is as follows:

⊙: very good (uniform and wide dispersion condition with no yarn bundles)

○: good (almost uniform and wide dispersion condition with almost no yarn bundles)

x : bad (uniform and narrow dispersion condition with many yarn bundles)

#### Industrial Applicability

According to the dispersing device of the present invention, a change in sectional area is small. Therefore, the turbulence of the carrier air flow is reduced to thereby uniformly and widely disperse the filaments on the moving collector surface. Accordingly, a web having a good appearance with less nonuniformity and less yarn bundles as compared with the prior art dispersing device can be obtained. Thus, the dispersing device of the present invention is suitable for the production of a nonwoven fabric.

#### Claims

1. A filaments dispersing device for the production of a nonwoven fabric, for dispersing filaments carried by an air flow and ejecting said filaments onto a moving collector surface, said filaments dispersing device being formed as a dispersing pipe comprising a pair of dispersing plates vertically extending so as to be opposed to each other and a pair of side plates connecting said dispersing plates, said dispersing pipe having an upper end formed with a filaments inlet and a lower end formed with an oblong filaments outlet surrounded by said dispersing plates and said side plates, said dispersing pipe having a shape such that a space  $t$  between said dispersing plates is decreased with an increase in distance  $z$  from said filaments inlet toward said filaments outlet, and that a space  $w$  between said side plates is increased with the increase in said distance  $z$ .

2. The filaments dispersing device as defined in claim 1, wherein a sectional area  $S$  of said dispersing pipe at an arbitrary portion thereof in a plane perpendicular to a line along said distance  $z$  is represented by an expression approximated to Expression 1 to be given below, and  $dw/dz \geq 0$  and  $d^2w/dz^2 \leq 0.6$  are satisfied for all values of said distance  $z$ .

Expression 1:  $S = a \times z + b$

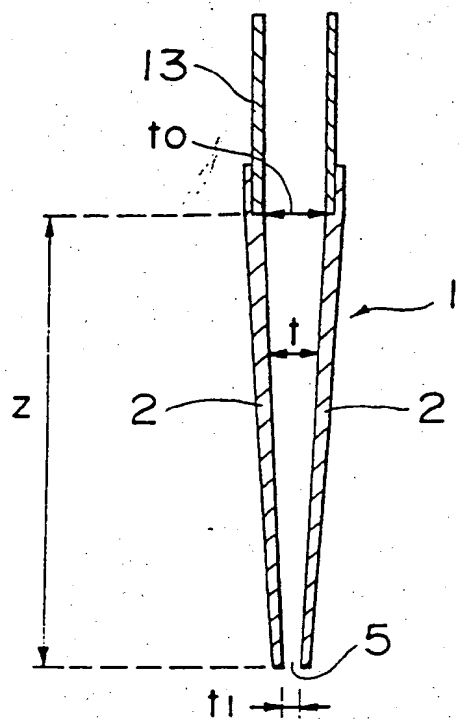
where  $a$  is a constant satisfying  $-1.00 \leq a \leq 1.00$ , and  $b$  is a sectional area of said filaments inlet.

3. The filaments dispersing device as defined in claim 2, wherein  $d^2w/dz^2 \leq 0.3$  is satisfied.

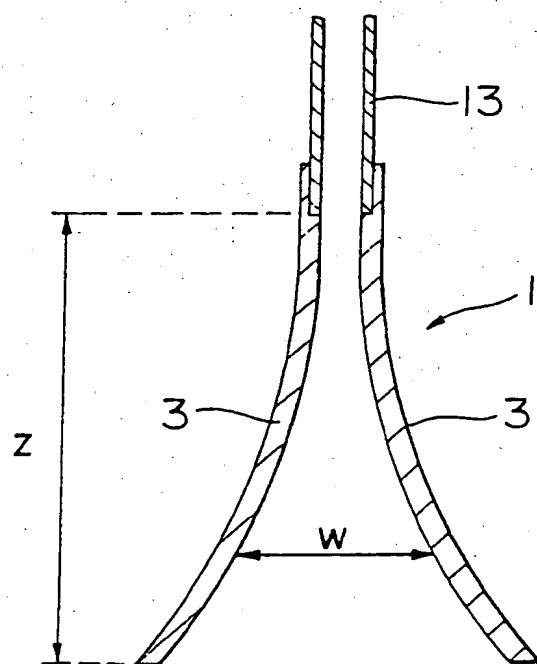
4. The filaments dispersing device as defined in claim 2, wherein said constant  $a$  is zero in Expression 1.

5. The filaments dispersing device as defined in claim 1, 2, 3, or 4, wherein a condition for carrying said filaments is such that an air velocity  $V_a$  at said filaments outlet is represented by a ratio of  $Q/S_{out}$  where  $Q$  represents a flow rate of said air flow and  $S_{out}$  represents a sectional area of said filaments outlet, and that said air velocity  $V_a$  is related with a filaments velocity  $V_f$  so as to satisfy  $2V_f < V_a < 4V_f$ .

[ 1 ]

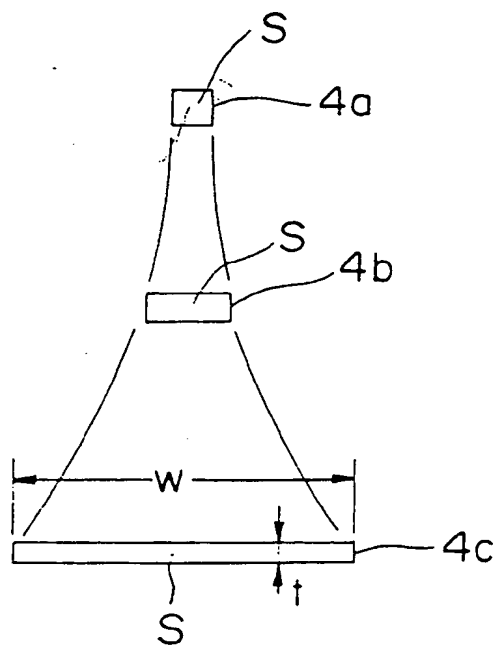


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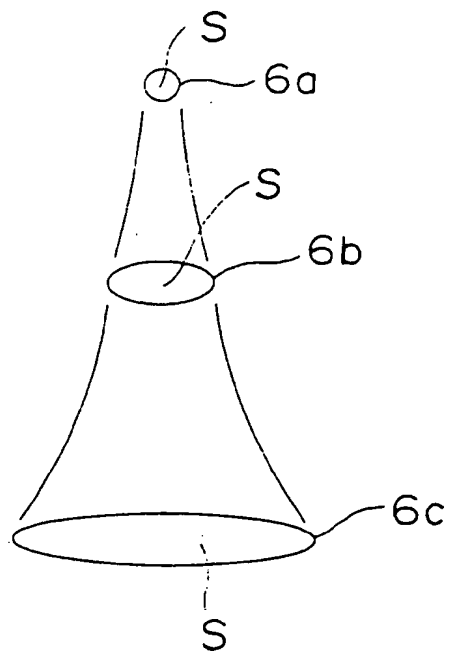




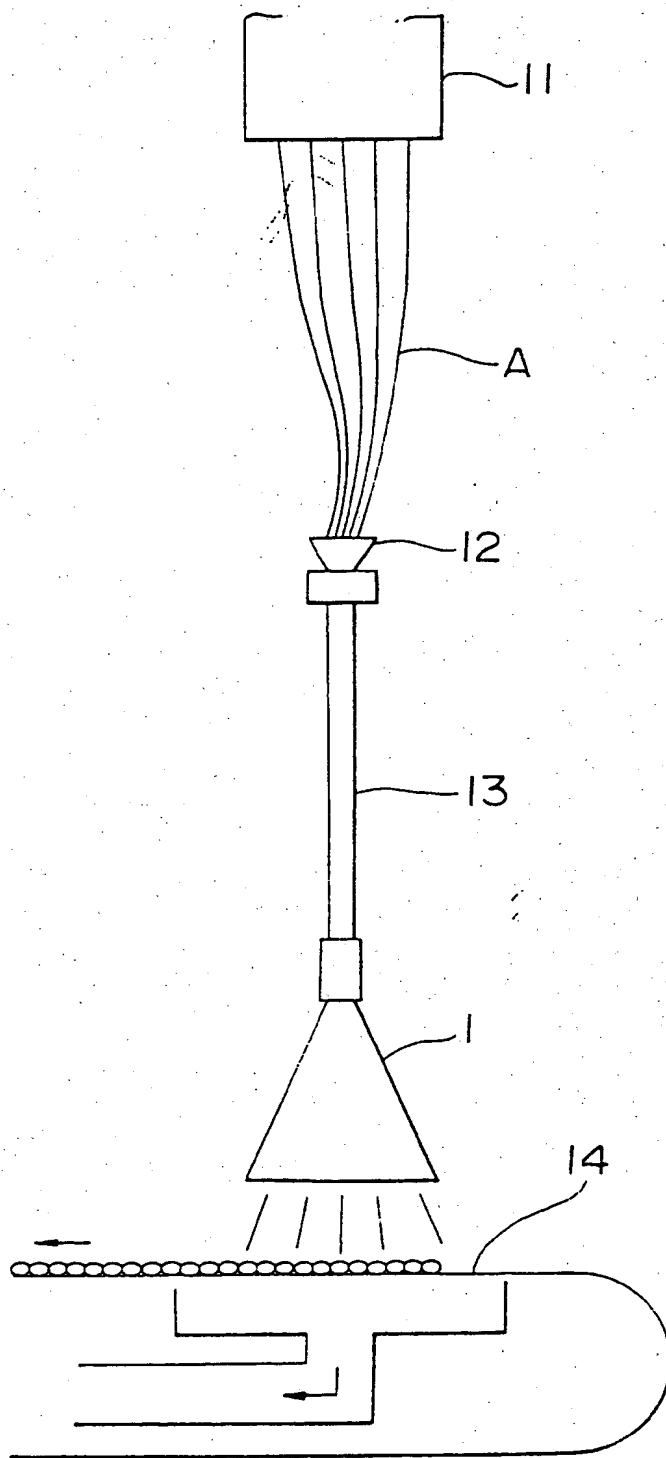
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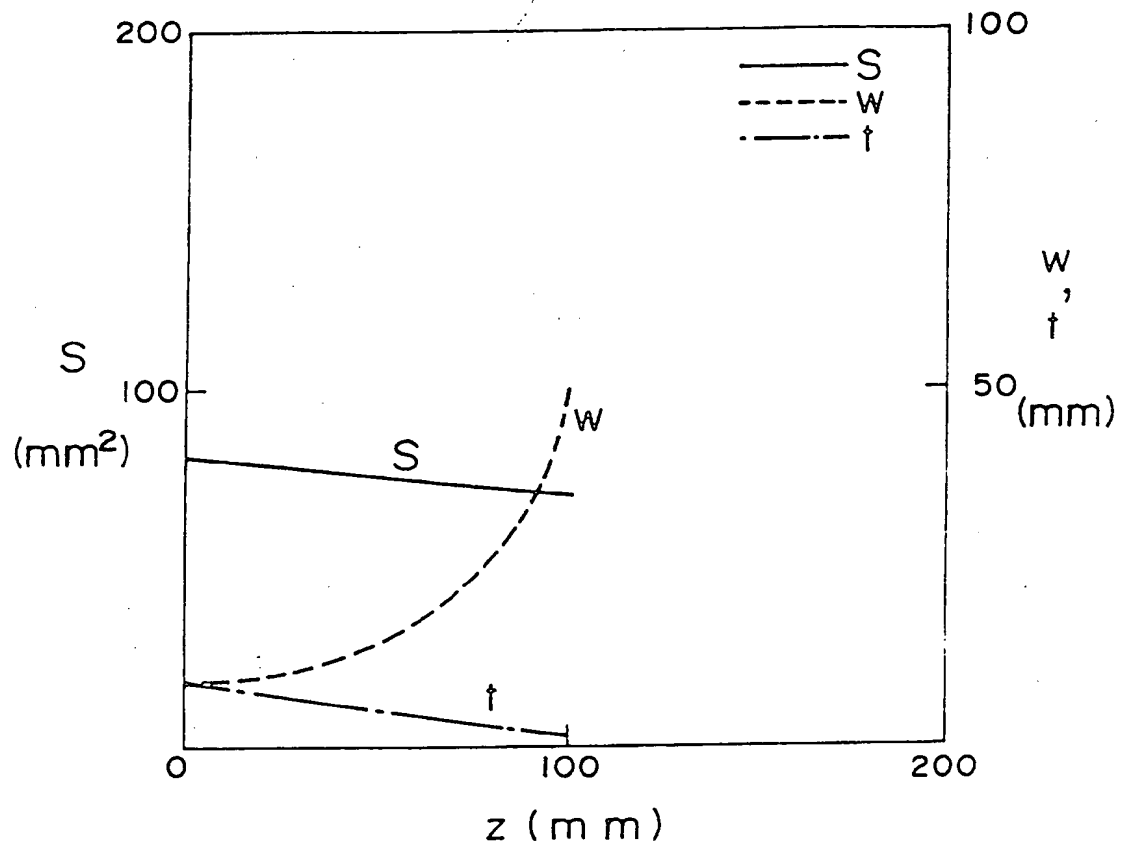
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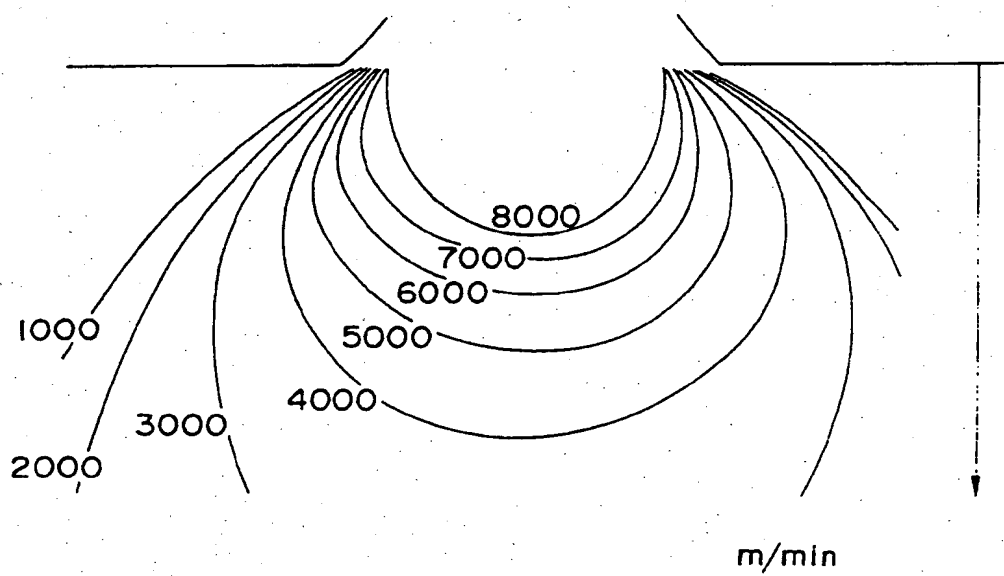
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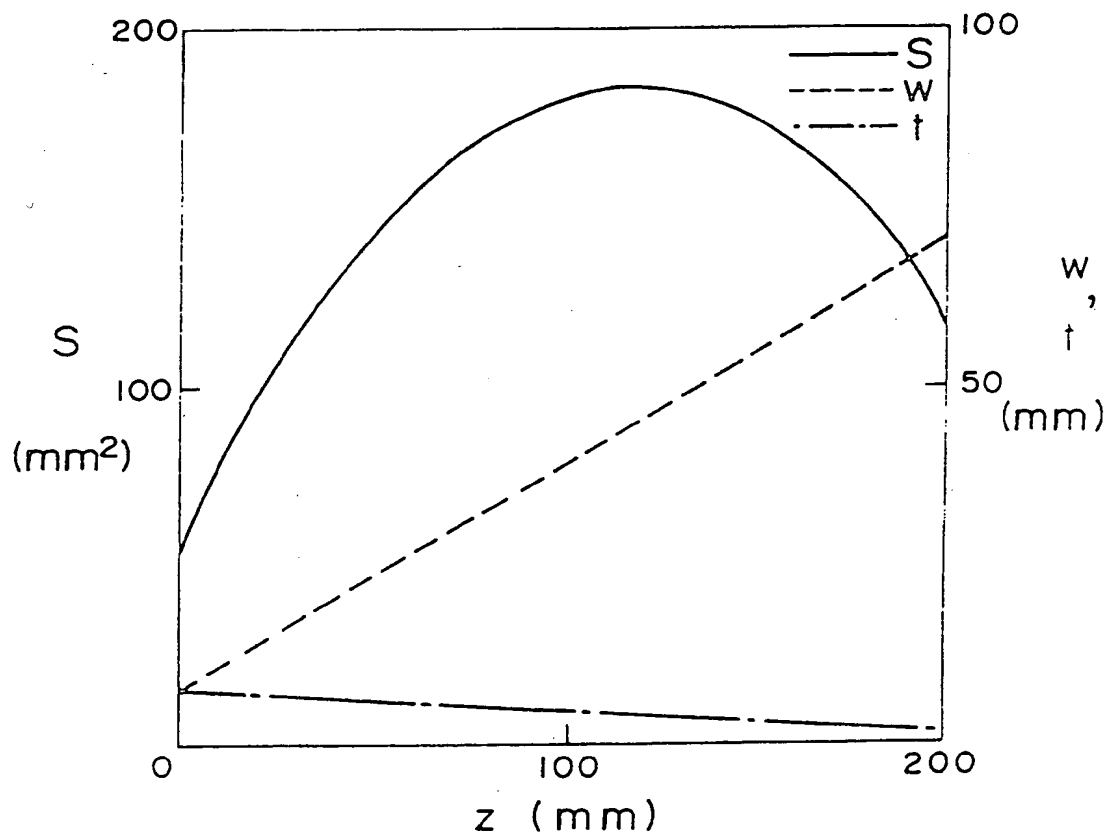
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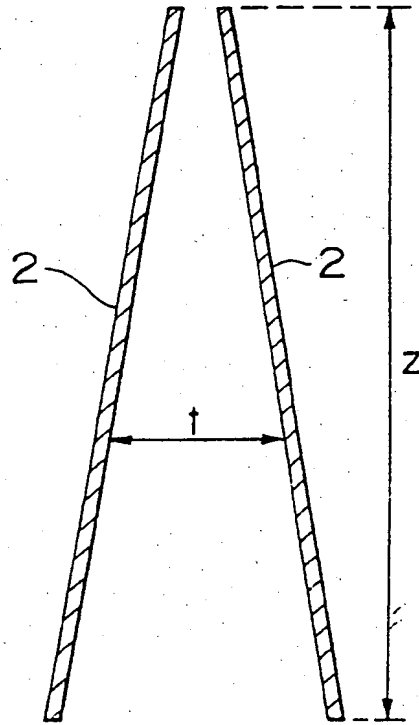
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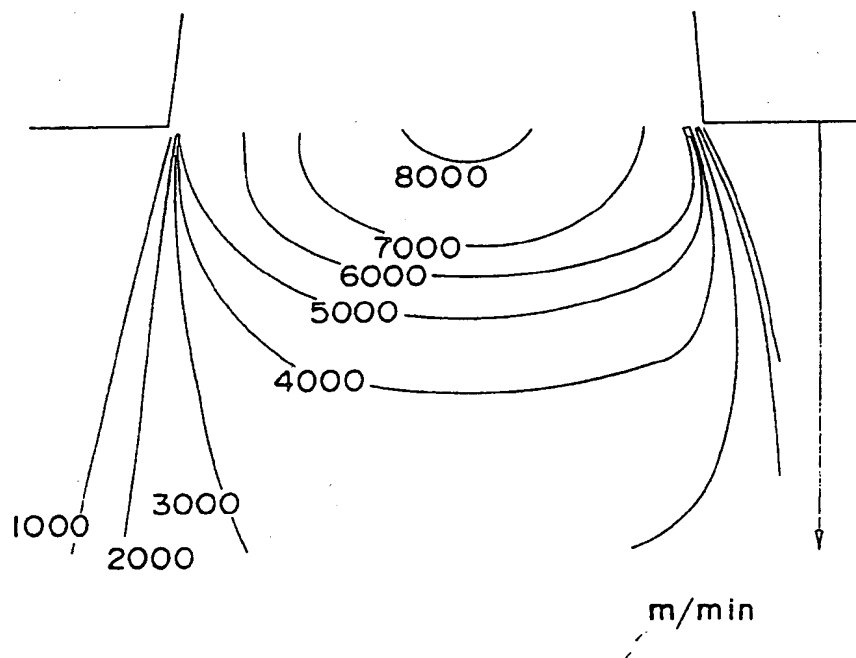
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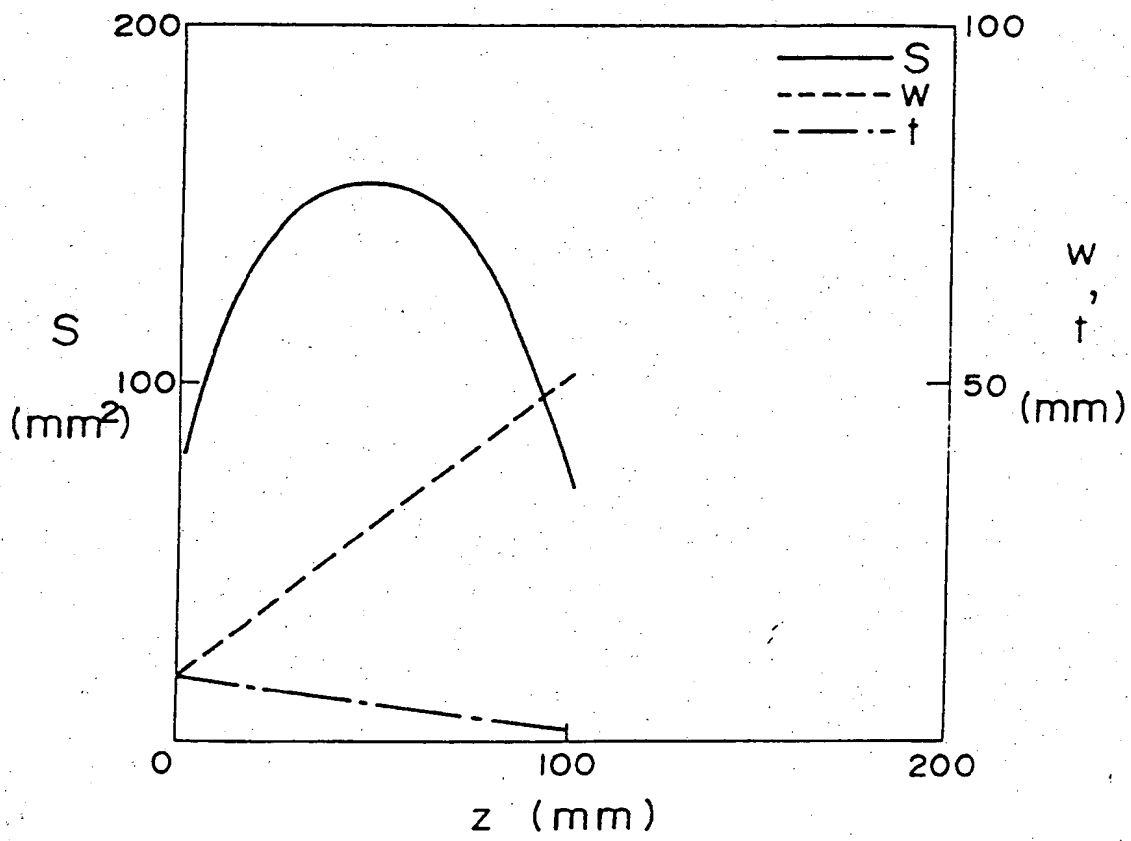
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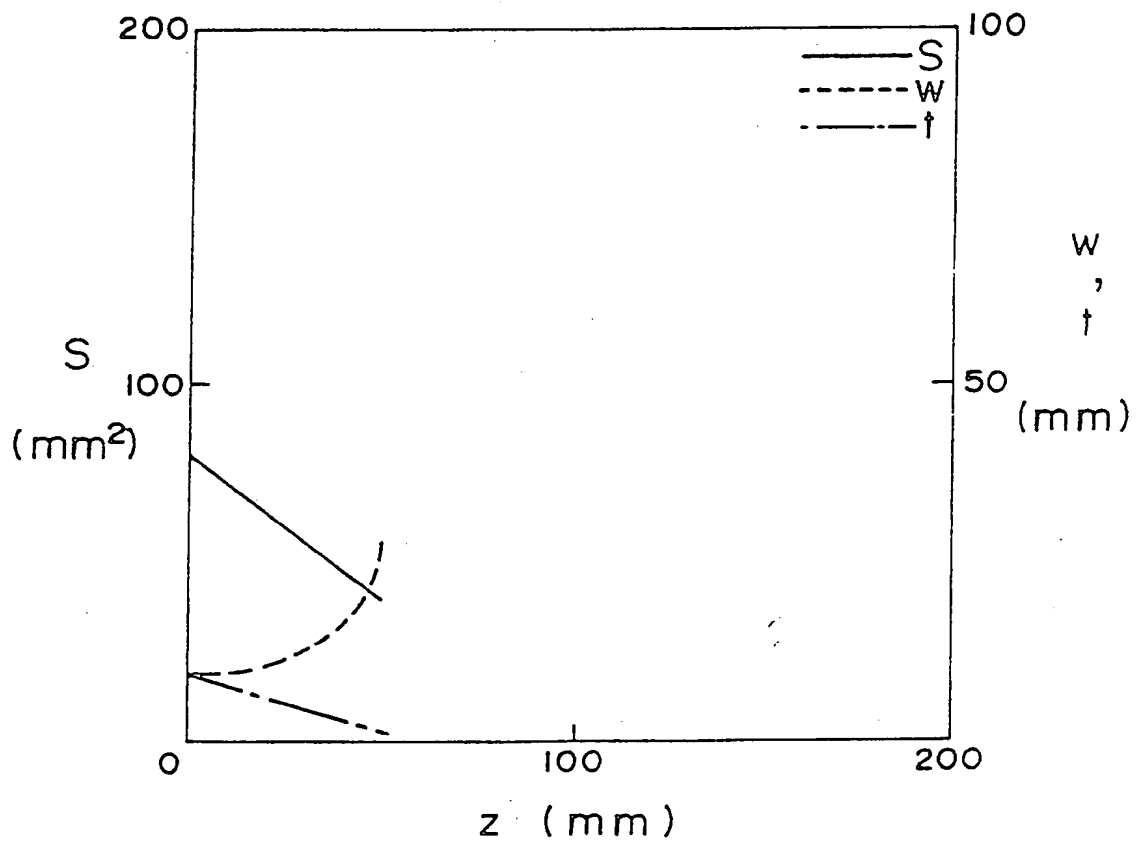


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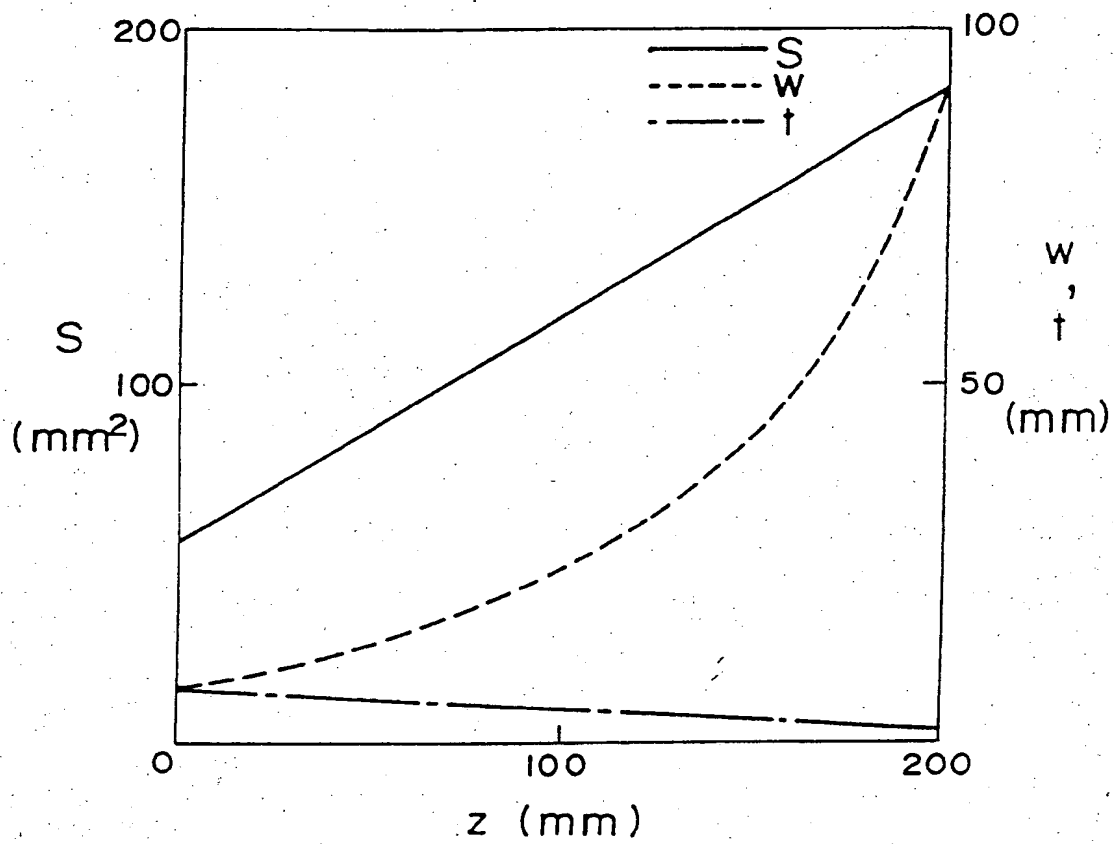




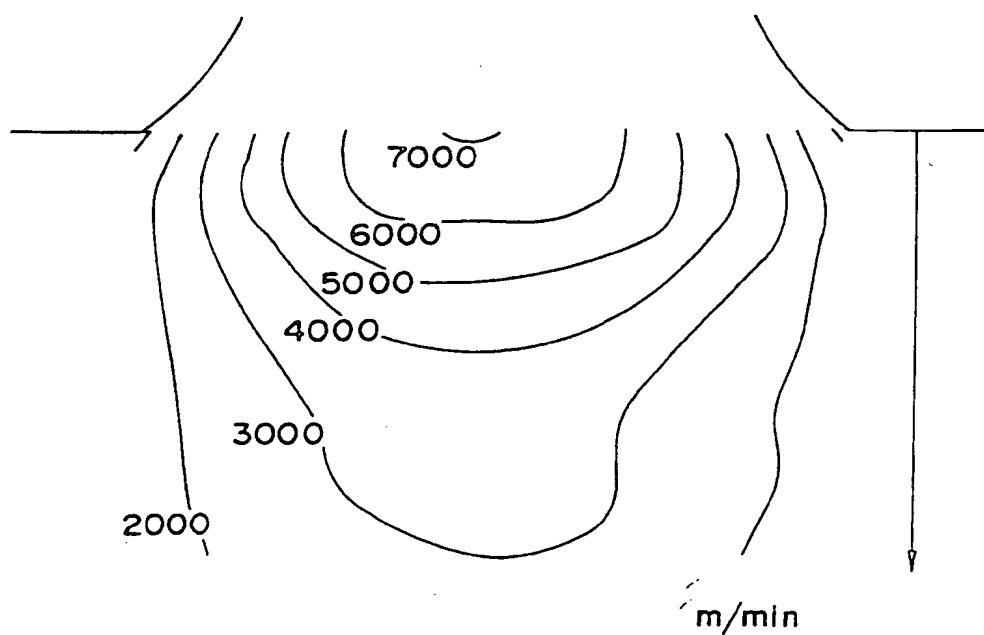
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[ 13 ]



[ 14 ]



# INTERNATIONAL SEARCH REPORT

International Application No PCT/JP92/00448

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl <sup>5</sup> D04H3/03		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System <sup>1</sup>	Classification Symbols	
IPC	D04H3/03, 3/16	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched <sup>8</sup>		
Jitsuyo Shinan Koho	1963 - 1991	
Kokai Jitsuyo Shinan Koho	1971 - 1991	
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	JP, A, 60-231856 (Asahi Chemical Industry Co., Ltd.), November 18, 1985 (18. 11. 85)	1
X	JP, B2, 63-38461 (Koturus Ltd.), July 29, 1988 (29. 07. 88), & WO, A1, 8002300	1
X	JP, B1, 49-430 (Toyobo Co., Ltd.), January 8, 1974 (08. 01. 74)	1
Y	JP, B1, 48-2907 (Japan Vilene Co., Ltd.), January 27, 1973 (27. 01. 73)	1
<p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"Z" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
July 7, 1992 (07. 07. 92)	July 14, 1992 (14. 07. 92)	
International Searching Authority	Signature of Authorized Officer	
Japanese Patent Office		